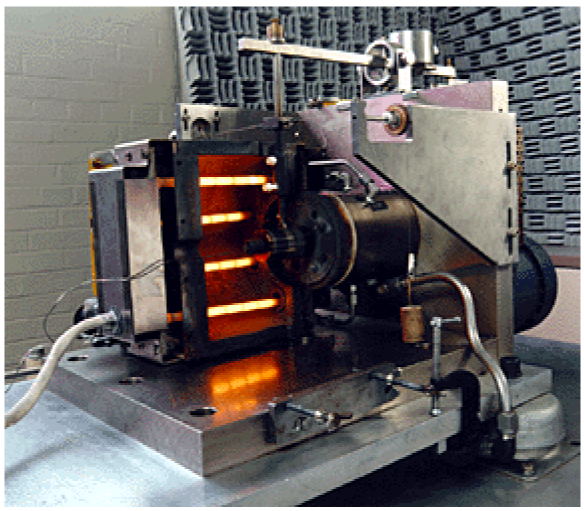
Unique Tuft Test Facility Dramatically Reduces Brush Seal Development Costs

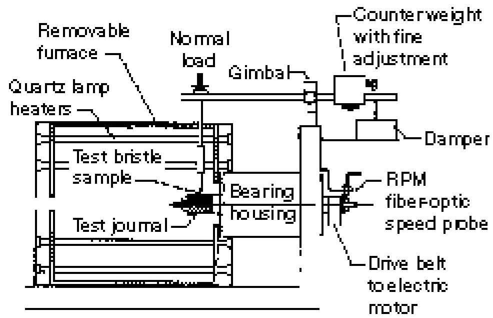
Brush seals have been incorporated in the latest turbine engines to reduce leakage and improve efficiency. However, the life of these seals is limited by wear. Studies have shown that optimal sealing characteristics for a brush seal occur before the interference fit between the brush and shaft is excessively worn. Research to develop improved tribopairs (brush and coating) with reduced wear and lower friction has been hindered by the lack of an accurate, low-cost, efficient test methodology. Estimated costs for evaluating a new material combination in an engine company seal test program are on the order of $100,000.



NASA Lewis brush seal tuft tester in operation with half of the furnace shell removed.

To address this need, the NASA Lewis Research Center designed, built, and validated a unique, innovative brush seal tuft tester that slides a single tuft of brush seal wire against a rotating shaft under controlled loads, speeds, and temperatures comparable to those in turbine engines. As an initial screening tool, the brush seal tuft tester can tribologicaly evaluate candidate seal materials for *1/10th the cost of full-scale seal tests*.

Previous to the development of the brush seal tuft tester facility, most relevant tribological data had been obtained from full-scale seal tests conducted primarily to determine seal leakage characteristics. However, from a tribological point of view, these tests included the confounding effects of varying contact pressures, bristle flaring, high-temperature oxidation, and varying bristle contact angles. These confounding effects are overcome in tuft testing. The interface contact pressures can be either constant or varying depending on the tuft mounting device, and bristle wear can be measured optically with inscribed witness marks.



Cross-section side view of the brush seal tuft tester.

In a recent cooperative program with a U.S. turbine engine manufacturer, five metallic wire candidates were tested against a plasma-sprayed Nichrome-bonded chrome carbide. The wire materials used during this collaboration were either nickel-chrome- or cobalt-chrome-based superalloys. These tests corroborated full-scale seal test results and provided insight into previously untested combinations.

As the cycle temperature for improved efficiency turbine engines increases, new brush seal materials combinations must be considered. Future brush seal tuft testing will include both metallic and ceramic bristles versus commercial and NASA-developed shaft coatings. The ultimate goal of this work is to expand the current data base so that seal designers can tailor brush seal materials to specific applications.

Bibliography

Fellenstein, J.A., et al.: High Temperature Brush Seal Tuft Testing of Metallic Bristles Versus Chrome Carbide. NASA TM-107238, 1996.

Fellenstein, J.A.; and DellaCorte, C.: A New Tribological Test for Candidate Brush Seal Materials Evaluation. NASA TM-106753, 1995.

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